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Case Report

Variations in renal arteries and pelvicalyceal system: A case report

Jakkula Akhil[1], **Priyanka Clementina Stephen**[1], **Yogesh Ashok Sontakke**[1], **Suma Yekapppa Hottigoudar**[1,*]

[1]*Dept. of Anatomy, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Dhanvantari Nagar, Puducherry, India*

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ABSTRACT

Purpose: To describe a complex case of anomalous kidneys involving right early division of renal artery, left accessory renal artery, bilateral upper polar arteries and bilateral extrarenal calyces. This is a very rare case documented having these four anomalies together.

Methods: The variations were observed during routine anatomical dissection in a male cadaver at department of anatomy, Jawaharlal Institute of Postgraduate Medical Education & Research (JIPMER), Pondicherry, India

Case Report: During dissection, multiple anatomical variations involving the structures at the hilum of right kidney were found. Right kidney showed early division of renal artery (RRA) 1.4 cm close to aorta. Left kidney showed accessory renal artery (LARA) 5 mm above origin of main renal artery (LRA), running obliquely entering the hilum. Two polar arteries were seen entering upper pole on right kidney as well as left kidney (RUPA1, RUPA2, LUPA1, LUPA2). Extrarenal calyces were observed to be present in both the kidneys, two on the right and three on the left.

Conclusion: The variations observed are of importance as multiple anomalies are present in a single cadaver. They are of significance during surgical procedures like renal transplantation, aortic surgeries and in radiological interpretation.

1. Introduction

In humans, majority of the population possess single renal artery for each kidney. The renal artery proper divides into anterior and posterior division close to the hilum of kidney.[1] But rarely early division of renal artery is found very close to aorta. In small percentage of population, accessory renal artery is present along with renal artery proper. The accessory renal artery commonly originates from the abdominal aorta, superior or inferior to the renal artery.[1] The accessory renal artery enters through the hilum or directly into the pole of the kidney.[2]

Generally, segmental arteries enter the hilum of kidney. Rarely they enter the poles of kidney directly. Ureteropelvic junction obstruction causing hydronephrosis was noted in the presence of lower accessory polar arteries due to its location anterior to the ureter.[1] Extra renal calyces i.e, major calyces being present outside the kidney, is a rare entity. It was commonly associated with other urogenital abnormalities such as ectopic kidney, bifid ureter, horseshoe kidney. Only 20 cases were reported worldwide.[3] The knowledge of the variations of renal arteries is significant when dealing with the renal transplantation, repair of abdominal aorta aneurysm, angiography.[4]

* *Corresponding author*.
E-mail address: suma1478@gmail.com (S. Y. Hottigoudar).

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2. Case Report

During routine undergraduate dissection of an adult male cadaver, the posterior abdominal wall contents were explored and multiple variations were observed involving the renal arteries and pelvicalyceal system. They are described below.

a. Left kidney – Accessory renal artery
b. Right kidney – Early division of renal arteries
c. Both kidneys – Upper polar arteries
d. Both kidneys – Extrarenal calyces

2.1. Left kidney – Accessory renal artery

On the left side, two renal arteries originated as the left renal artery (LRA) and left accessory renal artery (LARA), as shown in Figure 1 D,E and Figure 2 A. Accessory renal artery (LARA) originated from the aorta, 5 mm above the origin of LRA, crossed LRA anteriorly and travelled inferolaterally and entered the hilum, measuring 8 cm in length.

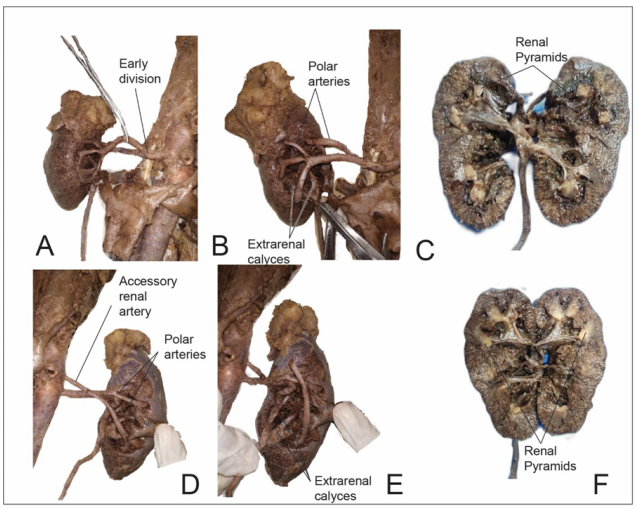

Fig. 1: Photographs of the variations in renal arteries and pelvicalyceal system; **A:** Early division of right renal artery; **B:** Two upper polar arteries (RUPA1, RUPA2) are seen entering upper pole. Extrarenal calyces of the right kidney held with forceps – Upper and lower major calyces (RUC, RLC); **C:** Cut section of right kidney showing renal pyramids and minor calyces; **D:** Accessory renal artery on the left (LARA). Two polar arteries (LUPA1, LUPA2) are seen entering upper pole; **E**: Extrarenal calyces of the left kidney– Upper, middle and lower major calyces (LUC, LMC, LLC); **F:** Cut section of left kidney showing renal pyramids and minor calyces.

2.2. Right kidney – Early division of renal arteries

On the right side, single right renal artery (RRA) originated from the aorta at the same level as LARA. Just after coursing for 1.4 cm from aorta, renal artery (RRA) bifurcated into anterior and posterior divisions. The early division is shown in Figure 1 A,B and Figure 2 A.

2.3. Both kidneys – Upper polar arteries

On the left side, LRA after passing about 3 cm, trifurcated into two upper polar arteries (LUPA1 AND LUPA2) and posterior segmental artery (LPSA), measuring 1 cm, 2 cm, 3 cm in length respectively. LUPA1 and LUPA2 entered the upper pole of kidney. On the right, RRA's anterior division gave branch of an upper polar artery (RUPA1), measuring 1.5 cm that entered the upper pole. RRA's posterior division gave another branch of upper polar artery (RUPA2), measuring 5 mm that entered the upper pole. The polar arteries are displayed in Figure 1 A,B,D,E.

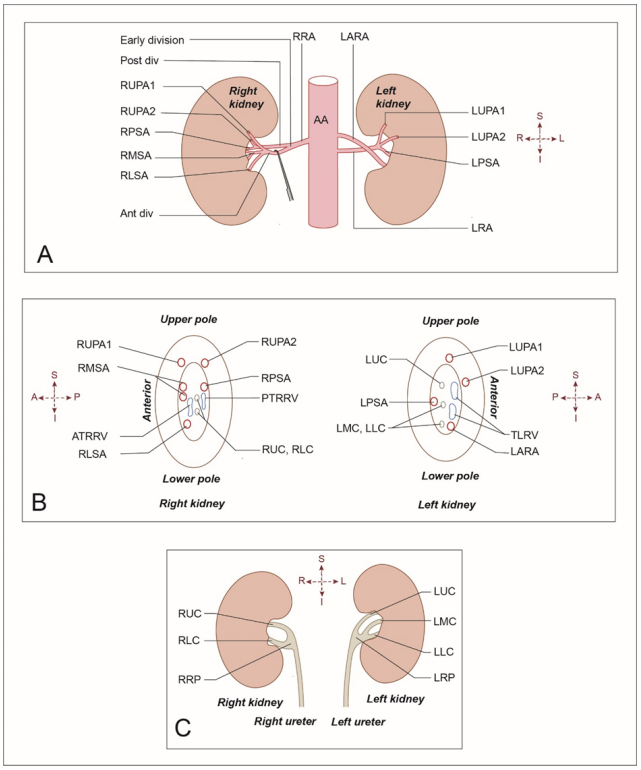

Fig. 2: Schematic illustrations of the variations in renal arteries and pelvicalyceal system; **A:** Right kidney: Early division of right renal artery, anterior division trifurcating into RUPA1, RMSA, RLSA, posterior division bifurcating into RUPA2, RPSA. Left kidney: Accessory renal artery on the left (LARA) and left renal artery trifurcating into LUPA1, LUPA2, LPSA; **B:** Presence of bilateral polar arteries and altered arrangement of structures at the hilum of right kidney and left kidney; **C:** Extrarenal calyces of right kidney and left kidney

2.4. Both kidneys – Extrarenal calyces

On the left kidney, three major calyces – left upper calyx (LUC), left middle calyx (LMC), left lower calyx (LLC) joined to form renal pelvis outside the hilum, 1 cm away

Table 1: Morphometric details of kidneys and associated structures

Morphometry	**Right kidney**	**Left kidney**
Kidney dimensions	9 × 4 × 4 cm	11.5 × 4.5 × 3.5 cm
Vertebral level	L1–L3	L1–L4
Arrangement of structures at hilum (anterior to posterior)	1. RUPA1, RMSA, RLSA 2. Anterior tributary of renal vein 3. Major calyces 4. Posterior tributary of renal vein 5. RUPA2, RPSA	1. LUPA1, LUPA2, LARA 2. Tributaries of renal vein 3. Major calyces 4. LPSA
Renal arteries	1. RRA–1.4 cm 2. Anterior division–3.5 cm a. RUPA1–1.5 cm b. RMSA–2 cm c. RLSA–3 cm 3. Posterior division–4 cm a. RUPA2–5 mm b. RPSA–1 cm	1. LRA–3 cm a. LUPA1–1 cm b. LUPA2–2 cm c. LPSA–3 cm 2. LARA–8 cm
Origin of renal arteries from the aorta	RRA is at the level of LARA RRA is 5 mm higher than LRA	LARA is 5 mm higher than LRA
Renal calyces	RUC: Length:1 cm Width: 4 mm RLC: Length: 5 mm Width: 4 mm	LUC: Length:1 cm Width: 4 mm LMC: Length:1 cm Width: 4 mm LLC: Length: 4 mm Width: 4 mm

RUPA1–right upper polar artery 1, RMSA–right middle segmental artery, RLSA–right lower segmental artery, RUPA2–right upper polar artery 2, RPSA–right posterior segmental artery, RUC–right upper major calyx, RLC–right lower major calyx, LARA–left accessory renal artery, LUPA1–left upper polar artery 1, LUPA2–left upper polar artery 2, LPSA–left posterior segmental artery, LUC–left upper major calyx, LMC–left middle major calyx, LLC–left lower major calyx.

from the medial border of kidney. On the right side, the two major calyces – right upper calyx (RUC), right lower calyx (RLC) combined to form renal pelvis outside the hilum, 1 cm away from the medial border of kidney. The extrarenal calyces are observed in Figure 1 B,D, Figure 2 C. The cut section of kidney showed renal pyramids and formation of minor calyces which united as major calyces. The pelvis was not observed in the cut section of kidney.

The details of morphometry observed in relation to kidneys and associated structures is given in Table 1.

3. Discussion

The metanephric kidney in the kidney is initially sacral in position, which ascends cranially to level of L2 by the time embryo length is 13 mm. The blood supply for the ascending kidney is provided by the arteries in the vicinity, such as middle sacral and common iliac arteries. In the third month of intrauterine life, the definitive renal artery is visible, arising from the caudal most of the three suprarenal arteries. Therefore, accessory or additional renal arteries at the hilum or the poles were regarded to be persistent mesonephric or lateral splanchnic arteries.[1] The early division of renal artery is supposed to be due to delayed contact between factors in mesenchyme of blood vessel and the factors in metanephros.[5] The embryological basis for extrarenal calyces was due to the premature branching of ureteric bud even before it comes into contact with the metanephric blastema.[6] It was supposed to be due to a discrepancy in the rate of growth between the metanephric tissue and the ureteric bud. The rapid development of ureteric bud compared to slow growth of the metanephric tissue can result in extrarenal calyces.[7]

The early division of renal artery is a significant finding in selecting the renal transplantation donor making the person ineligible. Accessory renal arteries are observed to cause high rates of renal graft failure. They are also important in abdominal aortic aneurysm repair and renal artery denervation for resistant hypertension.[8–10] Hydronephrosis can occur due to accessory renal artery compressing over the ureter.[11] Clinically, it has been observed that the upper polar arteries arising from the renal arteries are aligned much vertically leading to polar

infarction and high chance of graft failure due to renal vascular thrombosis.[4] The extrarenal calyces is a very rare entity associated with ectopic kidney, bifid ureter and other congenital anomalies. They were either incidental findings or found during workup for PUJO (pelvi-ureteric junction obstruction).[7] Extrarenal calyces can be damaged during urologic surgeries accidentally. They can also give a false appearance of hydronephrosis on retrograde pyelography.[3]

4. Conclusion

In the present case, right kidney showed early branching of renal artery and left kidney showed accessory renal artery. Two polar arteries were seen on each kidney entering the upper poles. Extra renal calyces, a very rare entity, were noted on both the kidneys. The knowledge of early division of renal artery benefits the clinicians in decision-making with regards to renal transplantation donor suitability and prevention of inadvertent injuries to the accessory renal arteries during aortic aneurysm surgeries. The understanding about extra renal calyces is significant in correct interpretation of pyelogram and to prevent accidental damage during urologic surgeries.

5. Source of Funding

The authors did not obtain any funding from any organization for this research.

6. Conflict of Interest

The authors declare that they have no conflict of interest.

7. Ethical Approval

The cadaver in which the variation was found are the bodies obtained through voluntary donation or unclaimed bodies. During donation, acceptance has been obtained for using the cadaver for academic purpose and research including for publication. But the data so obtained, is being shared in de-identified manner. Hence, no separate approval was obtained, as it is case report.

8. Authors' Contributions

Akhil J: Dissection, data collection, literature search and manuscript writing. Stephen PC: Literature search, manuscript editing. Sontakke YA: Project development, image illustrations, manuscript editing, data analysis. Hottigoudar SY: Project development, manuscript editing, data analysis. All authors approved the final manuscript.

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Author biography

Jakkula Akhil, Junior Resident https://orcid.org/0000-0002-6326-9475

Priyanka Clementina Stephen, Senior Resident https://orcid.org/0000-0003-0780-272X

Yogesh Ashok Sontakke, Additional Professor https://orcid.org/0000-0002-2592-2605

Suma Yekapppa Hottigoudar, Professor and HOD https://orcid.org/0000-0003-4081-7587

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